

Arecibo S-Band Radar Program

National Astronomy and Ionosphere Center
 Space Sciences Building
 Cornell University
 Ithaca, NY 14853-6801

Donald B. Campbell

Strategy

The high powered 12.6 cm wavelength radar on the 1000 ft Arecibo reflector is utilized for a variety of studies of solar system bodies. These include: 1) The radar mapping of the surfaces of Mercury, Venus, the moon and Mars in both senses (usually the two circulars) of receive polarization. 2) High time resolution ranging measurements to Mercury and Mars to obtain height profiles and scattering parameters in the equatorial region and to test relativistic and gravitational theories. 3) Measurements of the orbital parameters, scattering properties, figure and spin vectors of asteroids and comets. 4) Observations of the satellites of Mars, Phobos and Deimos, and the Galilean satellites of Jupiter.

Progress and Accomplishments

Two mainbelt asteroids, 1 Ceres and 78 Diana, plus three near-earth asteroids, 1990 MF, 4544 1989FB and 1991 AQ were observed. High time resolution ranging measurements were made to 1990 MF and 1991 AQ which greatly improved the precision with which their return can be predicted. Papers were published or submitted covering the observations of 1989 PB and 1986 DA. An attempt was made to observe Comet Austin but without success. Observations of Phobos and Deimos in November provided a measurement of Phobos' radar albedo, but no detection was obtained for Deimos indicating a lower radar albedo than Phobos. Measurements of the radar cross sections for Io and the icy Galilean satellites in early 1990 and 1991 provided additional phase coverage for these bodies. New techniques have been implemented which overcome some of the overspread problems associated with the radar imaging of Mars from earth. Images, although still at relatively coarse resolution, have been obtained in the cross-polarized (SC sense) showing the distribution of wavelength scale surface roughness. Data was obtained in two campaigns in 1990 which will provide 50m or better radar images of the moon in both senses of receive polarization. Analysis of the cross-polarized data for Venus continued with comparisons between the radar polarization properties of volcanic flows in the Eistla region on Venus and on the earth.

Projected Accomplishments

Three mainbelt asteroids are scheduled for observation, 7 Iris, 324 Bamberger and 796 Sarita. Given the rate at which small near-earth asteroids (NEA's) were discovered in 1990, it is

anticipated that there will be a number of opportunities over the next twelve months for Arecibo observations. There will be an extensive set of observations of Mercury in the summer of 1991 aimed at imaging the surface in the hemisphere not observed from the Mariner 10 spacecraft. The program of high resolution lunar observations will continue. Plans are being made to attempt some delay-Doppler observations of the icy Galilean satellites utilizing the techniques recently developed to overcome the overspread problem. Intensive analysis of the Venus polarization data will continue with emphasis on the contribution it can make to the results from the Magellan mission.

Publications

- "Radar Images of Asteroid 1627 Ivar", S.J. Ostro, D.B. Campbell, A.A. Hine, I.I. Shapiro, J.F. Chandler, C.L. Werner, and K.D. Rosema, *Astron. J.* **99** (6), 2012, 1990
- "Radar Images of Asteroid 1989 PB", S.J. Ostro, J.F. Chandler, A.A. Hine, K.D. Rosema, I.I. Shapiro, and D.K. Yeomans, *Science*, **248**, 1523, 1990
- "Venus: Crater Distributions at Low Northern Latitudes and in the Southern Hemisphere from New Arecibo Observations", D.B. Campbell, N.J.S. Stacy, and A.A. Hine, *Geophys. Res. Letters*, **17** (9), 1389, 1990
- "Orogeny and Large-Scale Strike-Slip Faulting on Venus: Tectonic Evolution of Maxwell Montes", R.W. Vorder Bruegge, J.W. Head, and D.B. Campbell, *J. Geophys. Res.*, **95** (B6), 8357, 1990
- "The Spin Vector of Venus", I.I. Shapiro, J.F. Chandler, D.B. Campbell, A.A. Hine, and N.J.S. Stacy, *Astron. J.*, **100** (4), 1990
- "Western Eistla Regio, Venus: Radar Properties of Volcanic Deposits", B.A. Campbell and D.B. Campbell, *Geophys. Res. Letters*, **17** (9), 1353, 1990
- "Venus Southern Hemisphere: Geologic Character and Age of Terrains in the Themis-Alpha-Lada Region", D.B. Campbell, D.A. Senske, J.W. Head, A.A. Hine, and P.C. Fisher, *Science*, **251**, 180, 1991
- "The Solar Wind Density Spectrum Near the Sun", W.A. Coles, W. Liu, J.K. Harmon, and C.L. Martin, *J. Geophys. Res.*, **96**, 1745, 1991
- "Radar Determination of Mars Surface Properties", R.A. Simpson, J.K. Harmon, S.H. Zisk, T.W. Thompson, and D. Muhleman, in *Mars*, U. of Arizona Press, Tucson, to be published in 1991

- "Radar Detection of Centimeter-Sized Orbital Debris: Preliminary Arecibo Observations at 12.6 cm Wavelength", T.W. Thompson, R.M. Goldstein, D.B. Campbell, E.G. Stansbery, and A.E. Potter Jr., submitted to *Geophys. Res. Letters*, 1990
- "Interstellar Nomads: The Problem of Detecting Comets", E.M. Jones, W.I. Newman, and D.B. Campbell, submitted to *Icarus*, 1990
- "Asteroid 1986 DA: Radar Evidence for a Metallic Composition", S.J. Ostro, D.B. Campbell, J.F. Chandler, A.A. Hine, R.S. Hudson, K.D. Rosema, and I.I. Shapiro, submitted to *Science*, 1991
- "Geology and Structure of Beta Regio, Venus: Results from Arecibo Radar Imaging", D.A. Senske, J.W. Head, E.R. Stofan, and D.B. Campbell, submitted to *Geophys. Res. Letters*, 1991